

[h2] What is Claimed is:

[1 (c1)]

1. A method of incorporating an impurity in a thin film comprising the steps of:

providing a substrate to a deposition chamber;

providing an impurity cell in the deposition chamber, the impurity cell having a pre-determined amount of an impurity in a confined volume;

introducing one or more gases into the deposition chamber for forming the thin film; and

removing the impurity from the impurity cell in a gas phase, wherein the impurity in the gas phase is incorporated into the thin film.

[2 (c2)]

2. The method of claim 1, wherein the impurity is selected from the group consisting of carbon and germanium.

[3 (c3)]

3. The method of claim 1, wherein the thin film comprises epitaxial or polycrystalline silicon.

[4 (c4)]

4. The method of claim 3, wherein the impurity incorporated into the epitaxial or polycrystalline silicon thin film comprises carbon in a concentration from about 1×10^{13} atoms/cm³ to a maximum solubility of carbon in the silicon thin film.

[5 (c5)]

5. The method of claim 1, wherein the impurity cell comprises a liquid, a solid, a liquid adhering to a solid, or a gas adhering to a solid.

[6 (c6)]

6. The method of claim 1, wherein the step of removing the impurity comprises desorbing the impurity from the impurity cell by providing a vacuum surrounding the impurity cell.

[7 (c7)]

7. The method of claim 1, wherein the step of removing the impurity comprises desorbing the impurity from the impurity cell by increasing the temperature of the impurity cell.

[8 (c8)]

8. Method of claim 1, wherein the deposition chamber comprises a vacuum chamber.

[9 (c9)]

9. An apparatus for incorporating an impurity in a thin film on a substrate arranged in a deposition chamber comprising:

an impurity cell in the deposition chamber, the impurity cell having a pre-determined amount of an impurity in a confined volume;

wherein, the impurity is removed from the impurity cell in a gas phase and is incorporated into the thin film during thin film deposition.

[10 (c10)]

10. The apparatus of claim 9, wherein the impurity is selected from the group consisting of carbon and germanium.

[11 (c11)]

11. The apparatus of claim 9, wherein the thin film comprises epitaxial or polycrystalline silicon.

[12 (c12)]

12. The apparatus of claim 11, wherein the impurity incorporated into the epitaxial or polycrystalline silicon thin film comprises carbon in a concentration from about 1×10^{13} atoms/cm³ to a maximum solubility of carbon in the silicon thin film.

[13 (c13)]

13. The apparatus of claim 9, wherein the impurity cell comprises a liquid, a solid, a liquid adhering to a solid or a gas adhering to a solid.

[14 (c14)]

14. The apparatus of claim 9, wherein the impurity is desorbed from the impurity cell by providing a vacuum surrounding the impurity cell.

[15 (c15)]

15. The apparatus of claim 9, wherein the impurity is desorbed from the impurity cell by increasing the temperature of the impurity cell.

[16 (c16)]

16. The apparatus of claim 9, wherein the deposition chamber comprises a vacuum chamber.

[17 (c17)]

17. A method of incorporating an impurity in a thin film comprising the steps of:

providing a deposition chamber;

providing a substrate arranged in the deposition chamber;

providing an impurity cell which introduces a pre-determined amount of an impurity in the deposition chamber;

providing an impurity source coupled to the impurity cell;

isolating the impurity source from the impurity cell and the deposition chamber, and delivering impurity in a gas phase from the impurity cell into the deposition chamber;

introducing one or more gases into the deposition chamber for forming the thin film, wherein the impurity in the gas phase is incorporated into the thin film; and,

isolating the deposition chamber from the impurity cell and the impurity source, and charging the impurity cell with impurity from the impurity source.

[18 (c18)]

18. The method of claim 17, wherein in the step of charging the impurity cell from the impurity source, the impurity cell remains in the deposition chamber.

[19 (c19)]

19. The method of claim 17, wherein the impurity cell comprises a liquid, a solid, a liquid adhering to a solid or a gas adhering to a solid.

[20 (c20)]

20. The method of claim 17, wherein the step of delivering the impurity comprises desorbing the impurity from the impurity cell.